Polymer Comply Europe

BPAF Consortium

Use description (Exposure-Based waiving).

BPAF properties and uses

BPAF (bisphenol AF, EC number = 216-036-7, CAS number = 1478-61-1) is used in the processing of fluoroelastomers (FKM) as a cross-linking agent to produce pre-compounds and full compounds which contain FKMs.

In order for the functions and characteristics of FKM to manifest themselves, bridge formation (bonding) between polymer chains, so-called “cross-linking”, is required. This cross-linking process takes place during moulding with crosslinking agents that have been previously compounded into the FKM.

Bisphenol crosslinking is the most widely used system for FKM, given its superior scorch stability and mould release characteristics, low mould staining, and fast cross-linking, as well as superior heat resistance and sealing properties of the crosslinked compound. These products are designed to perform to the highest requirements in extreme environments, especially in the following sectors:

- Transportation (Automotive, trains, Aerospace)
- Chemical processing industry
- Oil & Gas

The transportation sector is by far the predominant one.
The sophisticated polymer design, thanks to BPAF, is used for a myriad of technical rubber articles like O-rings, seals and fuel / turbocharger hoses due to their specific characteristics:

- Oil resistance
- Fuel resistance
- Low fuel permeation
- Chemical resistance
- Highest heat resistance (~230°C)
- Excellent sealing performance

A large part of the seals and fuel lines in cars, aeroplanes, etc., are equipped with BPAF-vulcanised products. The EU has its own set of emission standards for all vehicles must meet. Currently, standards are set for all road vehicles, trains, barges and 'nonroad mobile machinery' (such as tractors). A majority of the seals and fuel lines in cars, aeroplanes etc. are equipped with BPAF-vulcanised products specifically designed to meet the above-mentioned standards. Without these products, automotive companies in the EU will be unable to achieve emissions standards such as Regulation (EU) 2016/646 (of 20 April 2016 amending Regulation (EC) 692/2008 as regards to emissions from light passenger and commercial vehicles (Euro 6)). These requirements govern air pollutants released into the atmosphere. FKMs ensure that these pollutants cannot penetrate car part barriers and thus provides the EU Green Deal with the opportunity to materialise its goals.

Stressors

BPAF used for FKM products is incorporated and covalently bound to the polymeric matrix. Releases from polymers can occur due to the leaching of residual monomers in the polymer matrix or due to the breakdown of chemical bonds and the destruction of the polymeric structure. This process is initiated by stressors that can affect the products, depending on those affecting the material during their life cycle, primarily service life.
A number of environmental stressors such as solar radiation, exposure to rain and variation of temperature may be considered. During use FKM would be in contact with chemicals . As explained below those stressors are unlikely to result in emissions of BPAF as FKM based products are specifically designed to resist chemical stressors (see “Uses”) and are not exposed to environmental stressors.

Exposure conditions : no relevant exposure to external environment stressors

The **main applications** of FKM cured with BPAF products **are inside an automotive/plane/transportation engine (under the hood)**:

- Turbocharger hoses: improve thermal efficiency
- Particle filter hoses/Differential pressure hoses: reduce emission
- Fuel hoses/filler neck hoses: transport fuel without evaporation to the environment
- Seals and gaskets: prevent fuel/oil leakages - safety

One should in addition take into account that FKM would be found in the inner part of tubes or in gaskets and seals (i.e.) not in direct contact with environment

Exposure conditions under the hood

FKM products used for sealing provide excellent high temperature and aggressive fluid resistance when compared with other elastomers. They also combine the most effective resistance to chemicals and fluids such as oil, diesel or ethanol mix.

Turbocharger hoses improve the heat efficiency of an internal combustion engine. The hose which connects with the turbocharger is called a turbocharger hose. For air with high temperature and pressure to pass in the hose, fluoroelastomer material is used for the inner layer. The acid-resistant function is also requested by EGR (exhaust recirculation).

Filler neck hoses are another example, they connect between the fuel tank cap and a fuel tank. For fuel to pass, the excellent low fuel permeability of FKM is used.

Finally, the last example of why fluoroelastomers are critical for the safe and efficient functioning of the engine is particle filter hose to ensure low particle emissions, while monitors made with fluoroelastomers are used to assess when the filter needs replacing.

BPAF cured FKM can withstand continuous service temperatures of 200°C with spikes in temperature up to 270°C. But as the continuous operating temperature increases above 230°C the physical properties start to degrade.

In similar manner, FKM articles are subject to degradation in properties when exposed to certain types of additives used in automotive lubricating oil. Amine oil additives lead to excessive swelling of the elastomer as well as degrading the polymer backbone.
Exposure to basic conditions such as potassium hydroxide, solvents such as ketones, esters also lead to swelling of FKM articles. In all these situations, it is possible that unreacted BPAF or residues of BPAF complexes can migrate out of the FKM matrix into the solvent or oil system. Many customers impose specifications that do not allow for such excessive swelling to occur during the application. One should note though that the oil itself is not intended to be released and foreseeable conditions of use.

Application in chemical processing industry or oil and gas likewise are not exposed to external environmental stressors and are designed for the handling of chemicals .

Conclusions

BPAF is used in the processing of FKM fluoroelastomers as a crosslinking agent, and its main application is within the automotive industry. The FKM applications are not exposed to outdoor environments (under the hood) avoiding degradation by daylight (UV, sun) or water (rainwater, dew formation). The vulcanized material is resistant to the stressors of inside the engine environment that it might be exposed to. It is unlikely to have releases to the environment due to the degradation of the polymer chain as this would cause swelling of the material compromising the functionality.

In consequence of the absence of exposure of FKM materials during service life, the FKM based articles cross-linked with BPAF used in the applications described above should not be subject to testing on residual content or leaching to comply with restriction on its use (exposure based waiving).

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Applications (under the hood)

Figure 1. Turbocharger hoses

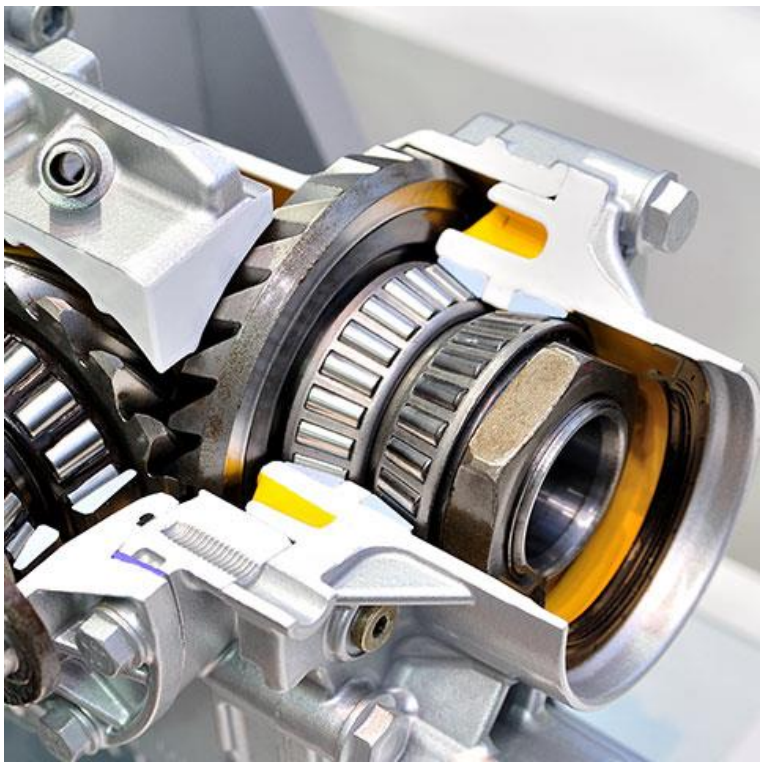

Figure 2. O-rings and gaskets seals

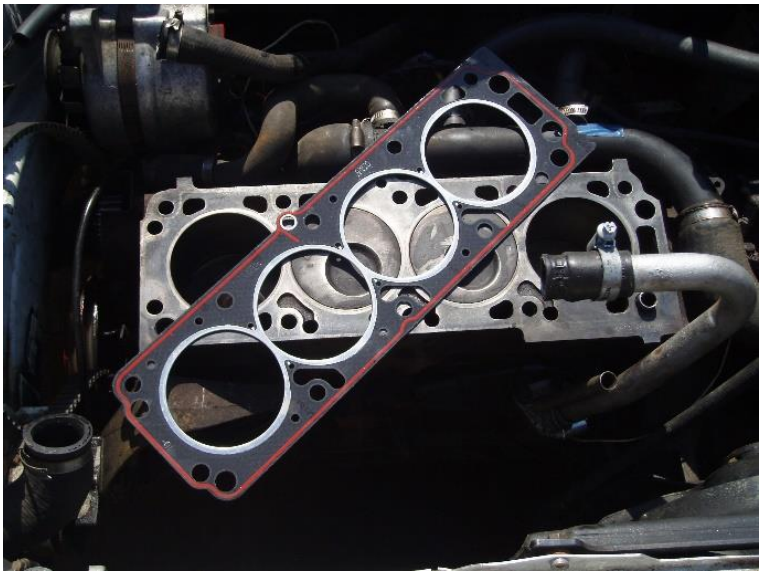

Figure 3. Shaft seals

Figure 4. Fuel hoses

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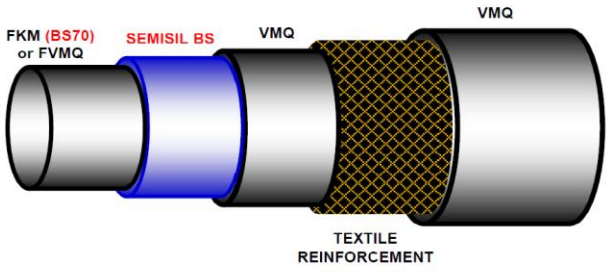

Figure 5. Fuel lines (FKM inner layer)